Geoinformation and Cartography in Higher Education: Body of Knowledge and Geospatial Capacity Building Perspectives

15th International Conference on Geoinformation and Cartography
and the Day of the Faculty of Geodesy of the University of Zagreb

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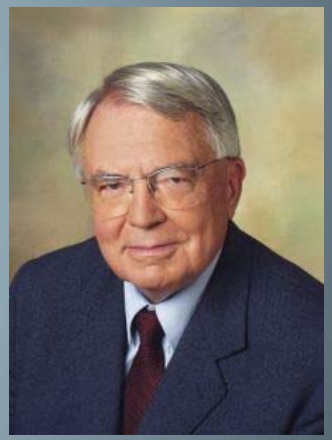
KÄRNTEN University of Applied Sciences

2+ centuries of surveying and cartography courses

5+ decades as an individual faculty



350. birthday

(founded on 23.09.1669)

Contents

- Geospatial Capacity Building Perspectives
  - Standard Curricula and Frameworks for their Implementation
  - … at Work … mostly from my own experience
- Geospatial Capacity Building Challenges

Geoinformation and Cartography …

- Geoinformation | GIS | Geographic Information Science & Technology (GIS&T)
  - Term established in GIS&T Body of Knowledge (DiBiase et al., 2006)
  - Generic spatial sciences discipline (Goodchild, 1992, 2010; Onsrud & Kuhn, 2018) emerged from ist original parent disciplines of Geography, Geodesy, Cartography, Computer Science and Planning (Strobl, 2017)
- Cartography
  - A professional and independent academic discipline (e.g., Gartner, 2014b)
    dealing with the art, science and technology of making and using maps (ICA, 2019)
    - Discussions on its relevance (Gartner 2014a; 2014b); defining a cartographer (Kraak, 2019b)
  - Often rooted in Geography and Geodesy
    widely re-establishing itself successfully within the GIS&T framework (Strobl, 2017; Kraak, 2017)

… in Higher Education

- GIS&T education (e.g. NCGIA; Unwin et al., 2012; Walford, 2017)

  training people to use GIS -> "GIS classes" & building domain knowledge

  -> curricula and syllabi for full geospatial education programs

  -> recognition as a professional field w. roles and job profiles

  -> standard BoKs, e.g. GIS&T BoK2 (Willson, 2014) or GI-N2K (Wallentin et al., 2015)

- Cartography education
  - The ICA Commission on Education and Training (https://education.icaci.org/)
  - basic cartography- classes - specializations in cartography – MSc programs (Kraak, 2017; 2019)
  - Knowledge area CV-Cartography and Visualization in GIS&T BoK2 (https://gistbok.ucgis.org/knowledge-area/cartography-and-visualization)
  - activities towards a BoK for cartography (Fairbairn, 2017; AAG&ICA 2019)

Value of GIS Education for the Economy: The GIS Market

Report by MarketsandMarkets™

a detailed analysis of the GISystem Market on the basis of component, function, end user, and geography

- valued at **USD 5.33 Billion in 2016**, expected to reach **USD 10.12 Billion by 2023**
  cumulative annual growth rate (CAGR) = 9.6% between 2017 and 2023
- key driving factors:
  development of smart cities and urbanization,
  integration of geospatial technology with mainstream technologies for business intelligence,
  and growing adoption of GIS solutions in transportation

-> Need for graduates who can utilize GIS&T for problem solving (Wikle, 2018)

Wikle, T. (2018). GIS&T Positions and Qualifications. *The Geographic Information Science & Technology Body of Knowledge* (2nd Quarter 2018 Edition), John P. Wilson (ed.).

Value of GIS Education for the Economy: The GIS Market (cont.)

An industry-wide shortage of competent staff is widely acknowledged, with no trend towards improvement in sight

Strobl, J. (2018). "Blog - Brainware for Geospatial Success." EUROGI - European Umbrella Organisation for Geographic Information

Geospatial Capacity Building Perspectives

Rajabifard, A., Ed. (2019). Sustainable Development Goals Connectivity Dilemma: Land and Geospatial Information for Urban and Rural Resilience. Leiden, CRC Press.

- United Nations Global Geospatial Information Management (UN-GGIM)
- UN-GGIM Academic Network

United Nations 2030 Agenda and Sustainable Development Goals (SDG)

- *an agreed global and united development policy to guide the way `all countries' collectively manage and report on the social, economic and environmental dimensions of people, planet and prosperity*
- *provides the main means and mechanisms for implementation and measuring and monitoring progress through to 2030*
- *presents the global policy community with a set of 17 SDGs –*
  significant development challenges that are almost entirely geographic in nature

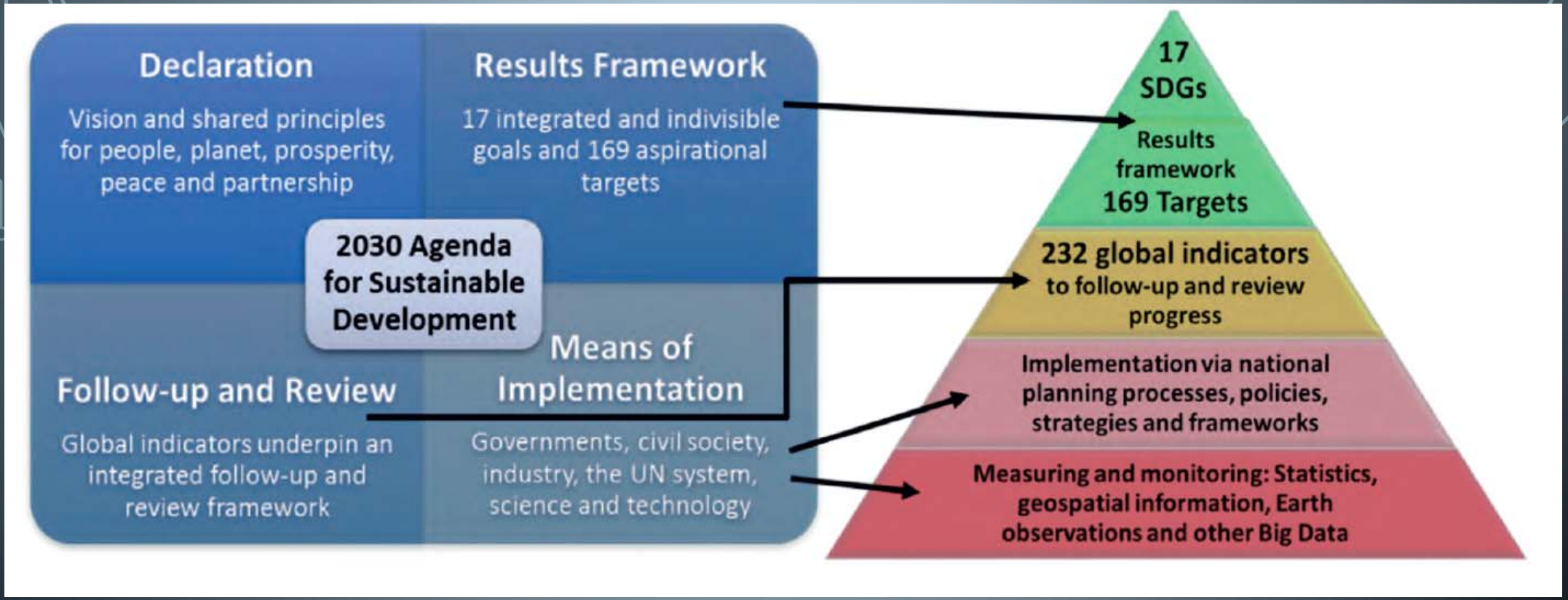


FIGURE 2.3 (Rajabifard, 2019, p.19)

The 2030 Agenda is an integrated plan of action structured in four main parts: […]

Any national SDG implementations will be sub-optimal without strategies and frameworks to ***integrate geospatial information*** *and other data into the measuring, monitoring and reporting processes.*

NATIONAL POLICY CONTEXT							
VISION	*The efficient use of geospatial information by all countries to effectively measure, monitor and achieve sustainable social, economic and environmental development – leaving no one behind*						
MISSION	*To promote and support innovation and provide the leadership, coordination and standards necessary to deliver integrated geospatial information that can be leveraged to find sustainable solutions for social, economic and environmental development*						
PRINCIPLES (VALUES)	Strategic Enablement	Transparent and Accountable	Reliable, Accessible and Easily Used	Collaboration and Cooperation	Integrative Solutions	Sustainable and Valued	Leadership and Commitment
STRATEGIC DRIVERS	National Development Agenda • National Strategic Priorities • National Transformation Programme • Community Expectations • Multilateral Trade Agreements • Transforming our World: 2030 Agenda for Sustainable Development • New Urban Agenda • Sendai Framework for Disaster Risk Reduction 2015–2030 • Addis Ababa Action Agenda • Small Island Developing States Accelerated Modalities of Action (SAMOA Pathway) • United Nations Framework Convention on Climate Change (Paris Agreement) • United Nations Oceans Conference: Call for Action						

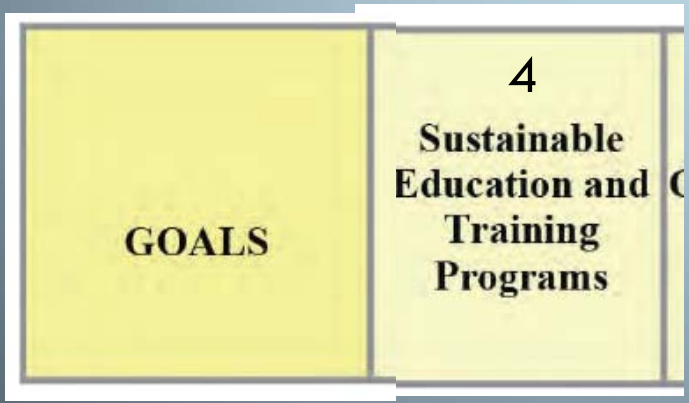
GOALS	Effective Geospatial Information Management	Increased Capacity, Capability, and Knowledge Transfer	Integrated Geospatial Information Systems and Services	Economic Return on Investment	Sustainable Education and Training Programs	International Cooperation and Partnerships Leveraged	Enhanced National Engagement and Comms.	Enriched Societal Value and Benefits

STRATEGIC PATHWAYS	Governance and Institutions	Legal and Policy	Financial	Data	Standards	Innovation	Partnerships	Capacity and Education	Comms. and Engagement
	Governance model Institutional structures Leadership Value proposition	Legislation Implementation and accountability Norms, policies and guides Data protection and licensing	Business model Investment Partnerships and opportunities Benefits realization	Fundamental data themes Data supply chain interlinkages Custodianship, acquisition and management Data curation and delivery	Legal interoperability Semantic interoperability Data interoperability Technical interoperability	Technological advances Promoting innovation and creativity Process improvement Bridging the digital divide	Cross-sector and interdisciplinary cooperation Community participation Industry partnerships and joint ventures International collaboration	Awareness raising Entrepreneurship Formal education Professional workplace training	Stakeholder identification Planning and execution Integrated engagement strategies Monitoring and evaluation

BENEFITS (REALISED)	Knowledge | Decisions | Development | Society | Economy | Environment Users | Citizens | Access | Technology | Applications | Value

FIGURE 2.6 (Rajabifard, 2019, p.29)
The components of the National Strategic Geospatial Information Policy Framework

VISION	*The efficient use of geospatial information by all countries to effectively measure, monitor and achieve sustainable social, economic and environmental development – leaving no one behind*



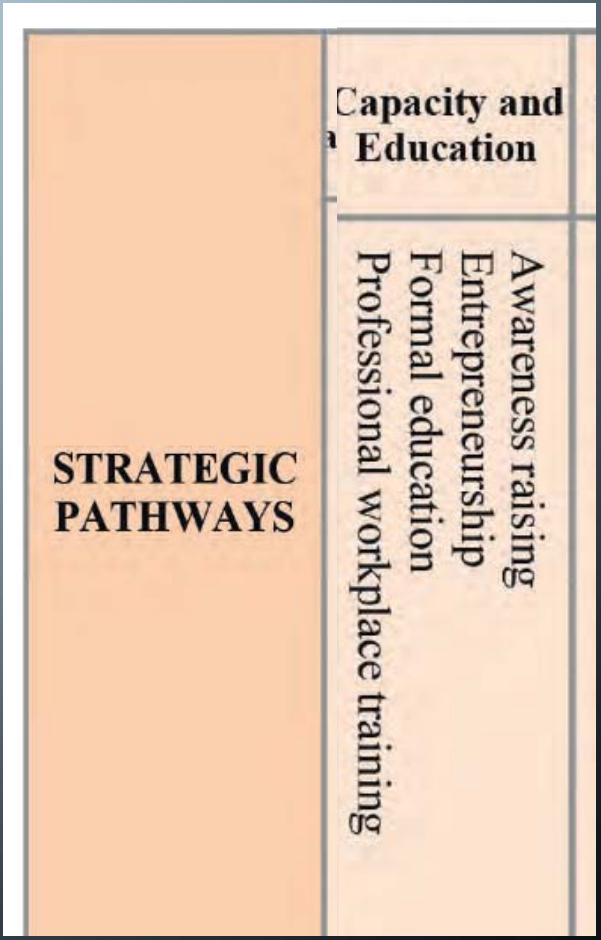
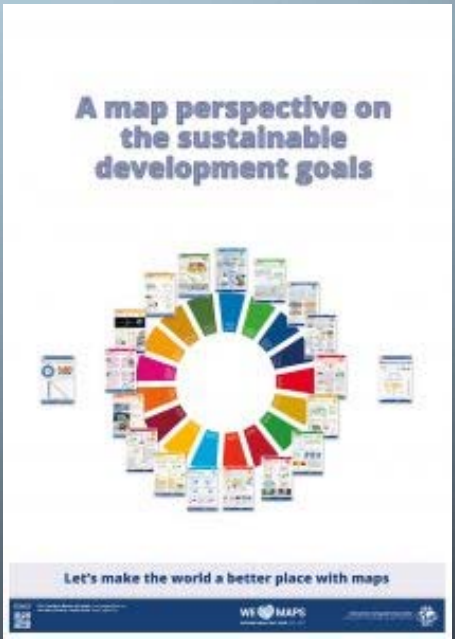


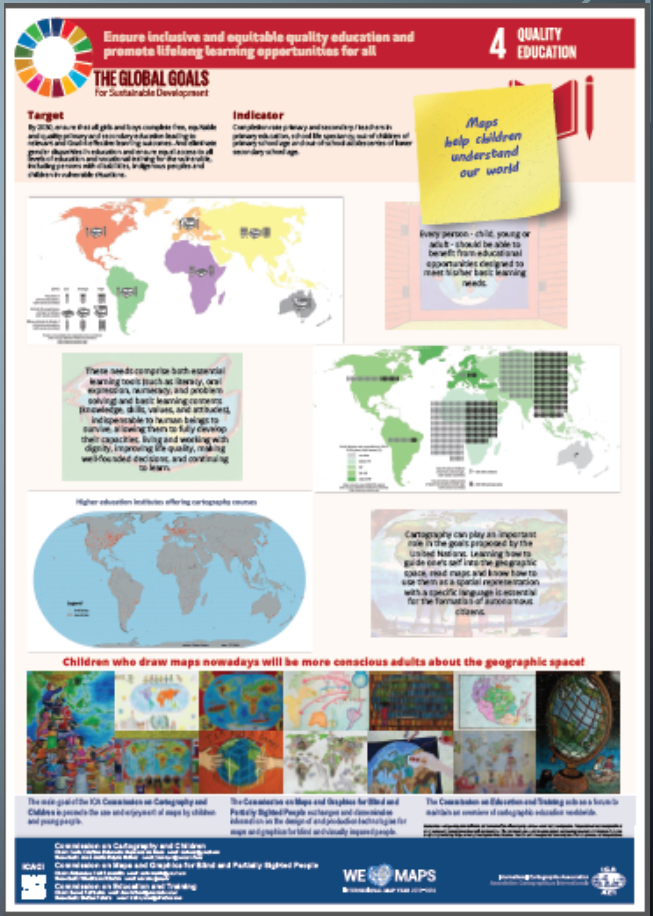
FIGURE 2.6 (Rajabifard, 2019, p.29)
The components of the National Strategic Geospatial Information Policy Framework

Geospatial Capacity Building Perspectives (cont.)

Kraak, M.-J. (2016). Cartography Contributes to Meeting Sustainable Development Goals. Arcnews: The Relevance of Cartography: A Cartographer's Perspective, ESRI. Fall 2016.

https://icaci.org/maps-and-sustainable-development-goals/





Geospatial Capacity Building Perspectives (cont.)

Strobl, J. (2019). The Geospatial Capacity Building Ecosystem - Developing the Brainware for SDI. Sustainable Development Goals Connectivity Dilemma: Land and Geospatial Information for Urban and Rural Resilience. A. Rajabifarad. Leiden, CRC Press: 213-219.

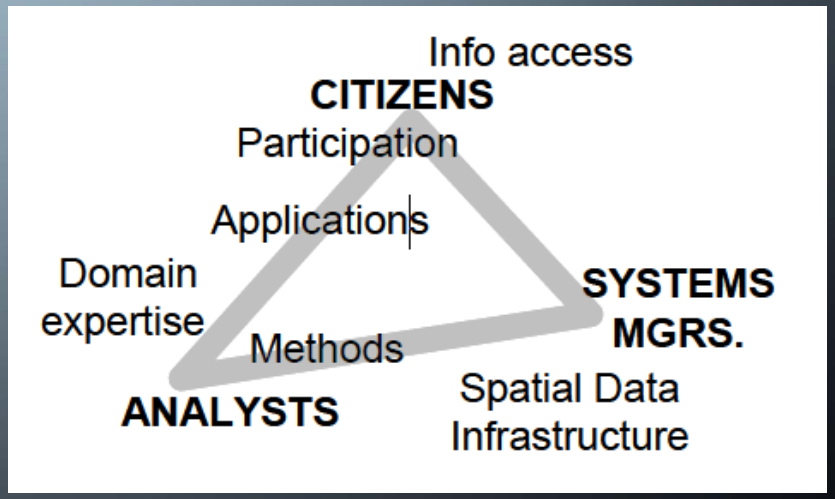
- *argues for an ecosystem view of lifelong learning at the core of building and maintaining the brainware for geospatial information systems supporting our livelihoods*
- *`Brainware', the human capacity and competence to manage Spatial Data Infrastructures (SDI) and related geospatial information frameworks*

Geospatial Capacity Building Perspectives (cont.)

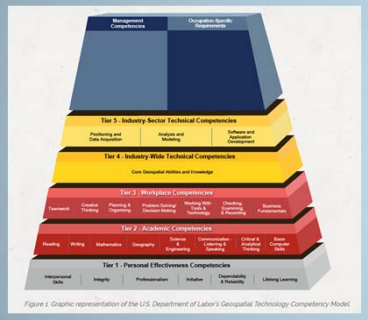
Strobl, J. (2008). Digital Earth Brainware. A Framework for Education and Qualification Requirements. Geoinformatics paves the Highway to Digital Earth. "gi-reports" des Instituts für Geoinformatik und Fernerkundung der Universität Osnabrück. J. Schiewe.

C – A – S Framework

- C Spatial Communication
- A Spatial Analysis
- S Spatial Systems



GIS&T and Cartography Standard Curricula and Frameworks for their Implementation



The NCGIA Core Curriculum in GIScience

NCGIA Core Curriculum 1990

U.K.'s RICS Curriculum for Teaching GISystems 1990

NCGIA Core Curriculum (revised) 2000

UCGIS GIS&T BoK 2006

Digital Earth Brainware Qualification Framework (Strobl) 2008

ICA Commission on Edu & Training

URISA Geospatial Management Competency Model 2010/16

Creating BoK for Cartography (Fairbairn, 2017)

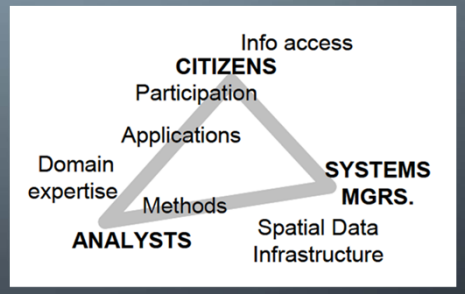
GI-N2K BoK 2016

GI-N2K

UCGIS GIS&T BoK 2.0 2018

BoK for Cartography Activities at AAG, ICA 2019

University Consortium for GEOGRAPHIC INFORMATION SCIENCE GIS&T Body of Knowledge



ICA Commission on Education and Training

Mission | Members | Activities | University programs | Education material | Mailing list | Educational vacancies

https://education.icaci.org/

Mission

The ICA Commission on Education and Training acts as a forum to maintain an overview of cartographic and geospatial education worldwide; to deliver presentations, papers, workshops and contributions to other programmes, which focus on educational material in the subject of cartography and geospatial information science & technology; and to investigate and report on technologies, concepts and methods of educational and training courses. The CET webpage serves as a depository of records for such information.

TERMS OF REFERENCE 2019-2023

The ToR collectively addresses the three basic functions of the CET:

- To support the ICA efforts of developing a Body of Knowledge (BoK) for cartography, which could be used for developing contemporary educational programmes and encouraging the creation of specific cartographic modules with valid and viable learning outcomes.

Towards a BoK for Cartography

- Fairbairn, David (2017). Creating a Body of Knowledge for cartography. Proceedings of the International Cartographc Assocciation, 1. https://doi.org/10.5194/ica-proc-1-35-2017
- Kraak, M.-J. (2017). Inspiring Lifelong Learning in Cartography. Arcnews: The Relevance of Cartography Series, ESRI. Summer 2017
- Discussions
  - Contributing to the Knowledge Area CV – Cartography and Visualization of the GIS&T BoK2
  - AAG 2019: whether cartography as a discipline needs its own BoK
  - 07/2019: "Geospatial and Cartographic Education – Contemporary Challenges and Opportunities" http://cet2019.cnu.edu.cn/
  - ICA 2019

GIS&T and Cartography Standard Curricula and Frameworks for their Implementation

…at Work

GIS&T Body of Knowledge

Geographic Information Science and Technology Body of Knowledge (GIS&T BoK) was developed to provide (Ahearn & Skupin, 2016, p.66):

(i) a resource for course and curriculum planning;

(ii) a basis for comparison of education programs;

(iii) a foundation for professional certification, program accreditation, and articulation agreements; and

(iv) a resource for HR professionals

Ahearn, S. C. and A. Skupin (2016). From Body of Knowledge to Base-Map: Managing Domain Knowledge through Collaboration and Computation. Advancing Geographic Information Science: The Past and Next Twenty Years. H. Onsrud and W. Kuhn, GSDI Association Press: 65-77.

Example : Geoinformation @ CUAS, Villach 2004/05

Reaccreditation of the diploma study program after 5 years
(started in 2000, 8 semester 240 ECTS Dipl.Ing.(FH) degree)

- Requirements from the CUAS administration
  - Implement the Bologna system
  - Output: BSc (180 ECTS) and MSc (120 ECTS)
- Requirements of the School of Geoinformation Team
  - Study content needs to follow „some standards“ in the GIS community
  - 2004 GIS&T BoK „Strawman Report“ used to revise the curriculum
    so our graduates can benchmark their education on the national and international edu-market

Example : Geoinformation @ CUAS 2016-2018

BSc Geoinformation and Environmental Technologies @ CUAS in Villach (6 semester, 180 ECTS)

- CUAS Administration requested restructuring on a number of IT-related BSc programs into a single „Information Technologies“ BSc
  - Common: Maths, Physics, Computer Science, compulsory elective subject, …
  - Distinctive: qualification profile - GIS&T
  - Framework, i.e. requirement
    - Retain the qualification profile while drastically reducing the GIS&T specific ECTS
  - Output: http://www.fh-kaernten.at/geoit

Example : Geoinformation @ CUAS 2016-2018 (cont.)

Analyse GEO

CARINTHIA UNIVERSITY OF APPLIED SCIENCES | FACHHOCHSCHULE KÄRNTEN

Relevante Basis:

Qualifikationsprofil

- Strobl, J. (2008) Digital Earth Brainware. A Frar
  In: Schiewe, J.; Michel, U.; Geoinformatics pav
  Universität Osnabrück (Hrsg.); Osnabrück, S. 1

Standard Curriculum – GIScie

- **GIS&T Body of Knowledge (BoK)** (DiBiase et a
  considered the main resource for specifying ir
  GIS program (BSc and MSc)
- **BoK2 project** (Wilson, 2014):
  Analysis of the importance of the knowledge a

Arbeitsmarkt - Analyse

- **GI-N2K assessment of workforce demand to**

Analyse des Qualifikationsprofils

CARINTHIA UNIVERSITY OF APPLIED SCIENCES | FACHHOCHSCHULE KÄRNTEN

BSc Studium

C1	C2	C3	G/R
A1	A2	A3	T/A
S1	S2	S3	P/M

<25%	25%

MSc Studium

C – Spatial Communication (Citizens)
A – Spatial Analysis (Analysts)
S – Spatial Systems (System managers)

Domain expertise

ANALYS

(Stro

Inhaltliche Schwerpunkte in der Ausbildung (Grobstruktur)

CARINTHIA UNIVERSITY OF APPLIED SCIENCES | FACHHOCHSCHULE KÄRNTEN

- **GIS-Grundlagen und GI Technologien**
  - konzeptionelle Grundlagen der GI Wissenschaft
  - GI Erfassungsmethoden inkl. z.B. GI Systeme, GPS, Fernerkundung, moderner Sensorik, …
  - GI Standards, Datenqualität, Interoperabilität
- **Analytische Methoden**
  - Wahrscheinlichkeitstheorie und Statistik, Interpolation, Mathematische Methoden…
  - Räumliche Analysis und Räumliche Statistik
- **Datenmodellierung**
  - Geodatenbanken, Modellierungswerkzeuge
  - Geodatenmanagement
- **Kartographie und Visualisierung**
  - Karten, Kartenentwurf, Karteninterpretation, Information Visualization
  - Koordinatensysteme und Projektionen
- **Designaspekte**
  - Applikationsentwicklung
  - WebGIS & GI Services
- **Angewandte Projekte, Berufspraktikum**

WWW.FH-KAERNTEN.AT

Example : UNIGIS@Salzburg (international) 2005-2011

- Online distance learning program specifically tailored to the needs of in-service professionals; https://unigis.at/en/welcome/
  - academic certificate or MSc, regionally offered dual degree
  - International students
  - Several study locations: Global Campus, Latin America, Central Asia, India, Nepal, Croatia
- At the time we looked into **quality aspects** of the program we offered

Car, A. (2007). Quality Aspects in Postgraduate Distance Education. In Teaching Geography in Higher Education. K. Donert (ed.), ESRI inc. with HERODOT.

Example : UNIGIS@Salzburg (international) 2005-2011 (cont.)

Car, A. (2007). Quality Aspects in Postgraduate Distance Education. In Teaching Geography in Higher Education. K. Donert (ed.), ESRI inc. with HERODOT.

UNIVERSITÄT SALZBURG

Towards a UNIGIS QA Concept: Preliminary Results

UNIGIS Common Core Curriculum vs UCGIS Body of Knowldege

- MSc(GIS) C
  - is compu
  - implemen establish Technolo
  - demonst of GIS&T acquire r their stuc

ZGIS

UNIVERSITÄT SALZBURG

Towards a UNIGIS QA Concept: Preliminary Results (2)

UNIGIS Common Core Curriculum vs UCGIS Body of Knowldege

- General framework when revising the C
  - *Internally*: our exist checked against th to be changed and
  - *Externally*: CCC is comparison to othe the UNIGIS networ
    - e.g. likewise prog the NCGIA Core UCGIS Body of K

ZGIS

UNIVERSITÄT SALZBURG

Towards a UNIGIS QA Concept: Preliminary Results (3)

UNIGIS Common Core Curriculum vs UCGIS Body of Knowldege

UCGIS BoK – Knowledge Areas	CCC – compulsory
AM. Analytical Methods	M1. GIS Introductic
CF. Conceptual Foundations	M2. Data Modelling
CV. Cartography and Visualisation	M3. Data Sources
DA. Design Aspects	M4. geoDBMS
DM. Data Modelling	M5. Spatial Statisti
DN. Data Manipulation	M6. OpenGIS and Infrastructures
GC. Geocomputation	M7. Geographical
GD. Geospatial Data	M8 Visualisation ar
GS. GIS&T and Society	M9. GIS Organisat Management
OI. Organisational and Institutional Aspects	

Basic structure of the UCGIS BoK and CC

ZGIS

CENTRE FOR GEOINFO

UNIVERSITÄT SALZBURG

Towards a UNIGIS QA Concept: Preliminary Results (4)

UNIGIS Common Core Curriculum vs UCGIS Body of Knowldege

Preliminary results from the comparison between CCC and BoK show the following:

- CCC or parts thereof that are not covered implicitly and/or explicitly in BoK
  - OpenGIS and Distributed GI Infrastructures (M6)
- BoK KA or parts thereof that are not covered implicitly and/or explicitly in CCC:
  - Geocomputation (GC1,2,4,5,7)
  - GIS&T and Society (GS2,6,7)
  - Organisational & institutional aspects (OI4)
  - Conceptual foundations (CF1, CF2.5-7)
  - Analytical methods (AM1, AM12.1-3)
  - Design Aspects (DA7 system implementation)

ZGIS

CENTRE FOR GEOINFORMATICS SALZBURG

Example : UNIGIS@Salzburg (international) 2005-2011 (cont.)

Strobl, J. and A. Car (2009). "Continuing Professional Education via Distance Learning - Success Factors and Challenges." Oesterreichische Zeitschrift fuer Vermessung & Geoinformation: Proceedings FIG Commission 2 - Conference "Navigating the Future of Surveying Education" Vol.1.

- Clearly Defined Professional Qualifications
- Qualifications and their acceptance depend on a number of factors like:
  - Curriculum and syllabus
  - Professional relevance and employability
  - Track record with alumni and in industry
  - Formal accreditation and quality indicators

Example : GIS&T-CroHE 2007-2009

TEMPUS III Joint European Project (JEP) "Geographic Information Science and Technology in Croatian Higher Education" (GIST-CroHE)

- University of Salzbrug – ZGIS; Jagiellonian University in Cracow; Faculty of Geodesy at the University of Zagreb
- €268,771, 2 year project, 01.09.2007
- Outputs:
  1. a revised MSc curriculum in GISc&T for the Faculty of Geodesy in accordance with the Bologna declaration and the modern, current GISc&T curricula, and supported with modern infractructure;
  2. an increased number of graduates in GISc&T coming from various fields.
- Outcomes :
  1. Increased quality of education in GISc&T at the Faculty of Geodesy and in Croatia in general.
  2. Increased presence of qualified professionals in GISc&T in Croatia

Car, A. and J. Strobl (2007). TEMPUS: GIS&T Position and Role in Croatian Higher Eductaion [online]. Sensors&Systems. https://sensorsandsystems.com/tempus-giscat-position-and-role-in-croatian-higher-education/

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Car, A. and D. Medak (2009). Lessons Learned from Creating and Implementing a Curriculum Considering Model Curricula and Standards in Higher Education - an Example from Croatia. Learning with Geoinformation IV. T. Jekel, A. Koller and K. Donert. Heidelberg, Wichmann: 196-199.

Example : GIS&T BoK for Minors in GIS (2016-)

Car, A. and J. Strobl (2016). "Minor Programs in the Geospatial Domain – Referencing the GIScience & Technology Body of Knowledge." GI Forum Journal **2016(1): 336-354.**

- Minor Programs in GIS&T
  - Aimed at students who wish to acquire a foundation in GIS&T
  - Offered as secondary subjects complementing a great variety of Major programs at undergraduate and graduate level (Strobl, 2008)
  - Focus on spatial competencies like geographic representation, analysis methods, mapping, or geospatial techniques (Verfaillie et al., 2012)
- Lack a framework for comparison or standardized core content reflected in learning outcomes
- We proposed one based on **GIS&T BoK** (DiBiase et al., 2006) as a reference document

Example : GIS&T BoK for Minors in GIS (2016-) (cont.)

Michael Goodchild (Foreword in Unwin et al. 2012, p.xvi):

"We teach mathematics and language skills to everyone – should we not also be teaching some subset of GIS&T to everyone?"

=

professionals

Unwin, D. J., K. E. Foote, N. J. Tate and D. DiBiase, Eds. (2012). Teaching Geographic Information Science and Technology in Higher Education, Wiley-Blackwell.

Example : GIS&T BoK for Minors in GIS (2016-) (cont.)

- Framework for analysis
  - Metrics: Credits ("weights") and Contents ("learning outcomes")
  - Baseline for empirical study: website survey of existing GIS Minors and document analysis
- Analysis of current minors based on
  - readily available (online) documentation
  - criteria: status / level / certification / content structure/ credits
  - Content structure and awarded credits show similarities => potential for comparison

=> subset of programs that reflect the diversity of academic environments in which the Minor programs are offered

Example : GIS&T BoK for Minors in GIS (2016-) (cont.)

Adrijana Car & Josef Strobl – Minor in Geoinformatics

Analysis of the Sample Minors

Contents

Course topics taught in the sample GIS Minors

Core	Electives
Foundations of GIS [Science | Systems]	IT-related courses, programming
Cartography and Visualization [maps | mapping | topographic and thematic cartography | coordinate systems]	**Applications**
Analysis [Spatial | Geographical]	Remote sensing
Quantitative methods [statistics]	Cartography
Geodata acquisition	Image analysis
Geodesign	GI Tools
Research methods	Quality of Geodata
GI Technologies [remote sensing, GPS]	Web dissemination
(Schulze, Kanwischer, and Reudenbach, 2013)	Project | Internship
	Discipline-specific courses

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Adrijana Car & Josef Strobl – Minor in Geoinformatics

Body of Knowledge for GIS Minors Proposal

Sources and Criteria:

I. **GIS&T BoK** (DiBiase et al., 2006):
Common core: 9 KAs and 26 of their constituent core Units, together with all of their Topics, considered the main resource for specifying course content for GIS Minors

II. **BoK2 project** (Wilson, 2014):
we consider course content of a GIS Minor to be the "core of the common core" of BoK,
candidate topics for a GIS Minor course must be rated as "high importance"

III. **GI-N2K assessment of workforce demand to shape GIS&T** (Wallentin, Hofer, & Traun, 2015)

IV. **GIS Minor curricula analysis** (as presented in this paper)
Common content:
concepts of GIScience, geodata acquisition, spatial analysis, cartography and visualization, GI-Technologies incl. remote sensing, GPS and GISystems, and GIS applications

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Example : GIS&T BoK for Minors in GIS (2016-) (cont.) Our Main Observations

- most of the programs consist of a combination of core and elective course(s), but the proportion of electives varies greatly
- to be taken as a serious add-on qualification, a Minor program should require roughly a full semester workload
- in general Minors tend to focus on general topics and practical skill sets, including
  - the foundations of GIScience,
  - data acquisition,
  - spatial analysis,
  - mapping and visualization,
  - the use of GI-technology

Example : GIS&T BoK for Minors in GIS (2016-) (cont.) basis for the design of a BoK of GIS Minors

content of GIS&T BoK as the main source for a model curriculum

(reported in Wallentin, et al. 2015; Wilson, 2014)

+

set of criteria derived for specifying course content

Example : GIS&T BoK for Minors in GIS (2016-) (cont.) Need for Further Debate

- help formulate core competencies acquired through a GIS-Minor
- identify the "core" topics in which any GIS Minor student needs to demonstrate some level of mastery
- agree upon comparable workloads and shares of electives between GIS Minors
- revise existing learning objectives and define new ones at the Topic level (GIS&T BoK2)
- the overall competency level that students should have already when they are about to start the undergraduate study is worth further exploration, particularly where problem-solving and critical creative spatial thinking are concerned
- differences with regard to GI core competences appropriate for different fields

Geospatial Capacity Building Challenges

Geospatial Capacity Building Challenge

There are well established foundations, starting from various "core curricula", including UCGIS' "Body of Knowledge" [http://gistbok.ucgis.org] and supported by EU projects like GIN2K [http://www.gi-n2k.eu].

Still, we see too few translations of these concepts and frameworks into attractive programmes of study.

(Strobl 2018, 2019)

Geospatial Capacity Building Challenge (cont.)

Development of geospatial educational ecosystem (Strobl 2019)

- Collective effort of stakeholders
  Higher Education institutions, industry, professional institutions, media
- Involement of „Brainware“ carriers
  - students in different learning stages & programs
    Slew new users using cartography & cartographers (Kraak 2017, 2019)

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